AMBIENT AIR QUALITY

IN

WINDSOR AND VICINITY

Annual Report 1985

May, 1986

Ministry
of the
Environment

D.A. McTAVISH, Director
Southwestern Region

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Technical Support Section
Southwestern Region

ONTARIO MINISTRY OF THE ENVIRONMENT
MAY 1986

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SUMMARY

The Ministry's air quality monitoring program conducted in the Windsor area revealed satisfactory air quality with respect to many air pollutants including sulphur dioxide, carbon monoxide and nitrogen dioxide. Fluoride levels were appreciably lower than in previous years.

In 1985 elevated levels of suspended particulates persisted in localized areas. Excessive levels were again measured in the vicinity of the casting plant of Ford Motor Company of Canada, Limited and additional controls for emissions have been requested. At station 12015 in west Windsor suspended particulate levels were quite high and the 24-hour criterion for desirable ambient air quality was exceeded 24 percent of the time. Sources affecting the levels at station 12015 are the Canadian Salt Company Limited, road traffic; industries in Wayne County, Michigan, and sources that contribute to the long-range transport of fine particulates.

Monitoring near Zalev Brothers Ltd. was increased in 1985 and unsatisfactory levels of suspended particulates were detected at monitoring sites close to the Company. Iron levels in the suspended particulates and a review of the wind conditions linked the elevated levels of suspended particulates to the scrap metal operations at Zalev Brothers Ltd. A liaison committee consisting of representatives from the Company, the public and government has been formed and a major review of the industrial processes and environment is being undertaken.

West Windsor experiences occasional elevated levels of total reduced sulphur compounds. Total reduced sulphur compounds tend to be malodorous. The elevated levels in west Windsor are believed to be attributable primarily to emissions from the coking ovens of the steel industry in Wayne County, Michigan.

Frequent excursions were again detected for the desirable ambient air quality criterion established for ozone, the most abundant photochemical oxidant in ambient air. The elevated levels are partly a result of local emissions but to a greater degree are a result of long-range transport of oxidants and precursor chemicals into the Windsor area. Ontario has established a special program to study the oxidant situation and to develop an appropriate control strategy. The U.S. Environmental Protection Agency is requiring individual states to implement oxidant control strategies by the end of 1987.

INTRODUCTION

The Ontario Ministry of the Environment operates a network of ambient air monitors in the Windsor area to measure levels of a number of pollutants that may adversely affect health, vegetation and the enjoyment of property. Data on the levels of pollutants are compared with Ontario's criteria for desirable ambient air quality. Data are also used to determine trends in air quality and therefore, the effectiveness of pollution abatement. As well, information is provided on the effects of specific sources of pollutants and for use in the formulation of strategies to control emission sources. The air monitoring program is complemented by the Ministry's phytotoxicology surveys which determine effects of air pollutants on vegetation.

This annual report deals specifically with ambient air quality in the Windsor area. Detailed information on pollution abatement activities may be obtained from the Windsor District Office.

DESCRIPTION OF MONITORING NETWORK

The Ministry operates continuous and intermittent ambient air monitors at fixed sites throughout the Windsor area. Ideally, monitoring would be conducted at the same sites year after year in order to provide a historical trend for air quality. However, many stations have had to be relocated or terminated because of local interferences or changing land-use patterns. Nevertheless, the number of existing historical stations is deemed adequate to evaluate the long-term trend information.

The main monitoring station is located in the downtown area in order to evaluate air quality where emissions from motor vehicles and commercial establishments are most prevalent. There are a number of monitoring stations in west Windsor, which is close to a heavily industrialized portion of Wayne County, Michigan.

In 1985, four monitoring sites for suspended particulate matter were estabished in the vicinity of Zalev Brothers Ltd. to better define the impact of emissions from the Company's scrap metal operations on neighbourhood air quality. Also, in 1985 the Ministry did not collect meteorological data. Late in 1985 construction began in west Windsor on a new meteorological tower which was placed in operation in February 1986.

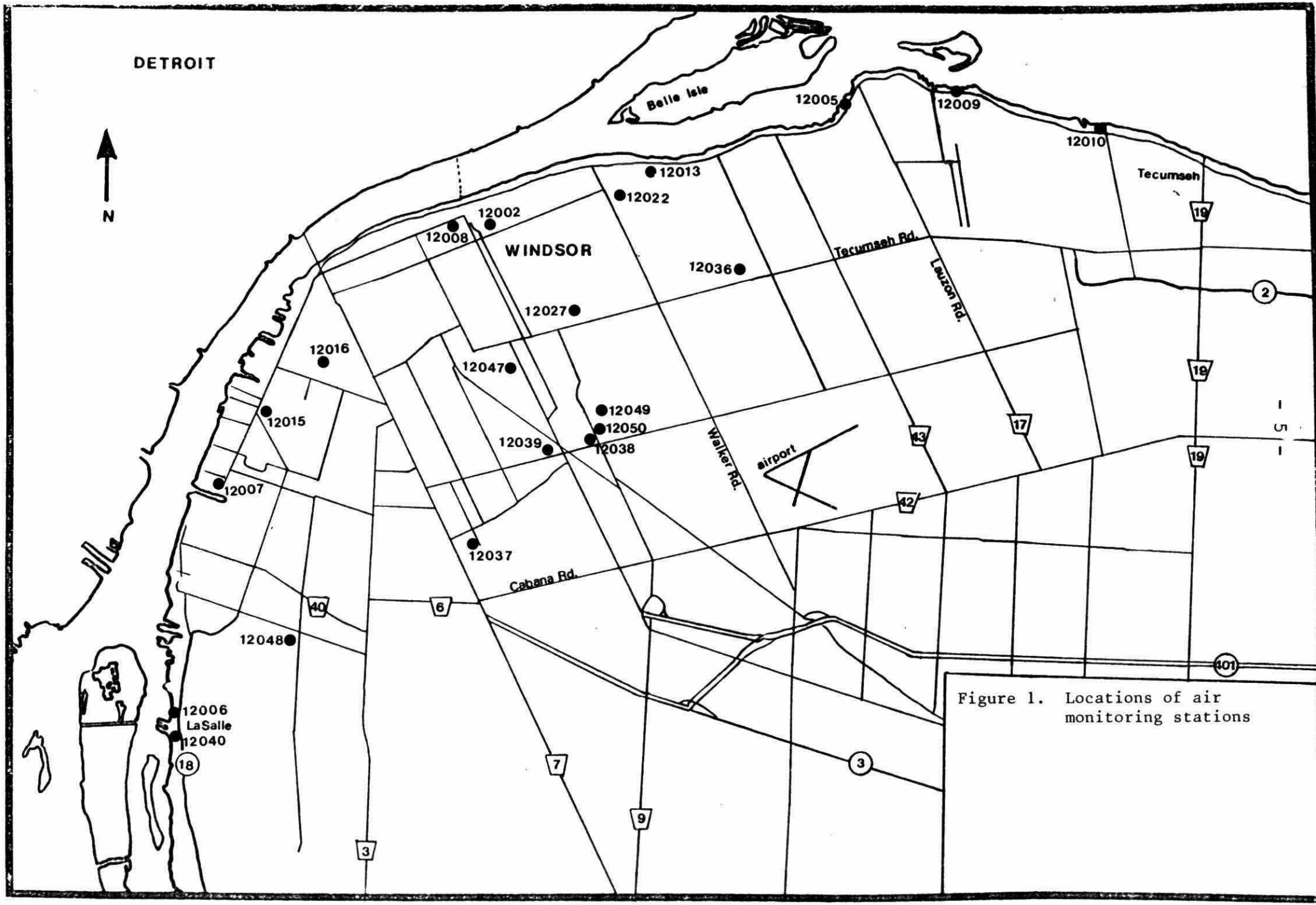
The location of the Ministry's monitoring stations in the Windsor area are indicated on Figure 1 and are described in Table A1 of Appendix 1.

The pollutants monitored at the various stations are listed in Appendix 1, Table A2. Ontario's criteria for desirable ambient air quality with respect to these pollutants and the prime factors supporting these criteria appear in Appendix 1, Table A3.

MONITORING AND PROGRAM RESULTS

PARTICULATES

The iron and steel industry, foundries, power generating plants utilizing fossil fuels and road traffic are primary sources of particulates that adversely affect air quality in Windsor. Wind-blown particulates from open fields, sand and coal piles, roadways and roofs are also significant sources.


DETROIT
N
Belle Isle
12005
12009
12010
Tecumseh
12013
12022
12002
12008
WINDSOR
Tecumseh Rd.
12036
Lauzon Rd.
12027
12016
12047
12049
12050
12015
12039
12038
Walker Rd.
airport
12007
12037
Cabana Rd.
12048
12006
LaSalle
12040
I 5 I
Figure 1. Locations of air monitoring stations

Measurements for particulates are reported as suspended particulates and soiling index. Levels of suspended particulates are determined by drawing measured volumes of air through a filter for 24 hours and subsequently weighing the quantity of particulates collected on the filter. The particulates trapped on the filters may also be analyzed for other parameters such as metals, sulphates and nitrates.

Soiling index is determined by measuring the difference in the amount of light transmitted through a filter before and after ambient air is drawn through the filter for one hour. The amount of light transmitted through the filter is affected by the quantity, size, shape and opaqueness of particulates retained on the filter. Light transmitted through the filter is measured by a photo-electric cell and the soiling index may be calculated immediately. This immediate availability of the soiling index in contrast with the time-consuming laboratory analysis required for total suspended particulate measurements has resulted in soiling index being used in the Air Pollution Index as an indicator of levels of suspended particulates.

Suspended Particulates

Two criteria for desirable ambient air quality exist for total suspended particulate matter. One is 120 micrograms of suspended particulates per cubic metre of air (ug/m^3) averaged over a 24-hour period. The other criterion is an annual geometric mean of 60 ug/m^3. The criterion for 24-hours is based on impairment of visibility and adverse health effects associated with combined concentrations of sulphur dioxide and suspended particulates. The annual criterion is based on public awareness of suspended particulates and property damage.

During 1985 filters were exposed using Hi-Vol samplers at 17 sites in the Windsor area. At all sites, except stations 12008 and 12016, samples were collected on a frequency of every-sixth-day. At station 12008 sampling was conducted every day to provide information by which it could be determined if the every-sixth-day sampling schedule is representative of the whole year. At station 12016 an every-third-day schedule was utilized. In addition, at some of the sites near Zalev Brothers Ltd. more frequent sampling was conducted to give better coverage of weekends and more information when most of the samplers were started early in 1985. A summary of total suspended particulate (TSP) data collected from 1972 through 1985 appear in Table 1.

For a number of years sampling has been conducted at station 12039 near Zalev Brothers Ltd. Early in 1985 four additional sites were located in the vicnity of Zalev Brothers Limited. The 1985 suspended particulate data from the five stations near Zalev Brothers were evaluated along with wind speed and direction data available from the Windsor Airport. A detailed report on the 1985 data was provided to The Liaison Committee - Zalev Brothers Ltd., which has representatives from the Company, Government and the public. A detailed evaluation will not be provided in this report. The data reveal an impact from emissions from Zalev Brothers at all five monitoring stations. Total suspended particulate levels and the percentage of iron in the particulates were appreciably greater when winds were blowing from the Company towards the air monitoring sites. The data reveal that station 12038, located at the Ivy Rose Motel, and station 12050 located at a private residence on Charles Street had the higher levels of particulates in 1985 than the other stations. The 24-hour criterion was exceeded by 27 percent and 15 percent of the samples collected at stations 12050 and 12038 respectively, compared to 7, 2 and

Table 1. Summary of data for total suspended particulates.

Station	Year													
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	Annual geometric means (ug/m³)													
12002	159	133	108	74	76	82	79	80	77	69	62	53	50	50
12005							I.D.	63	55	45	45	36	38	41
12006												49	48	56
12007													(67)	73
12008	126	126	116	82	80	87	80	80	71	58	55	53	57	59
12008S											58	60	61	59
12009	79	82	61	52	58	54	52	57	58	46	46	36	36	43
12010	85	86	58	46	54	47	46	53	47	40	39	31	33	42
12013	151	145	113	89	98	113	100	98	75	65	68	65	66	77
12015	183	147	152	105	113	93	93	98	108	87	70	59	79	90
12016				88	88	95	84	85	83	67	63	50	54	56
12036						72	63	72	70	55	53	49	49	53
12037						67	68	62	60	49	39	42	47	46
12038														(79)
12039								79	71	71	53	49	50	54
12047														46
12049														57
12050														75
Percentage of values above 24-hour criterion														
12002	70	58	43	14	15	21	18	16	19	9	11	4	0	2
12005							4	4	2	2	2	0	2	2
12006												6	0	2
12007													(7)	15
12008	57	55	47	17	19	24	16	17	12	6	4	2	5	4
12008S											4	4	6	9
12009	16	25	10	2	5	7	9	4	9	0	4	0	0	4
12010	23	27	17	2	10	6	7	0	0	0	0	0	0	2
12013	65	69	44	26	37	40	40	42	15	5	18	16	14	18
12015	80	66	84	33	42	25	27	33	46	16	8	3	22	24
12016				20	24	22	23	20	20	6	5	3	5	5
12036						11	9	15	13	2	2	0	2	2
12037						10	15	2	2	2	2	0	2	2
12038														(15)
12039								14	8	3	6	2	0	2
12047														2
12049														6
12050														25

I.D. - Insufficient data to compute a representative geometric mean.

( ) - Annual geometric mean and percentage of values above 24-hour criterion based on data not representative of total year.

Data for station 12008S are every-sixth-day sampling results extracted from the daily sampling data for station 12008.

2 percent for stations 12049, 12039 and 12047, the other monitoring stations in the vicinity of Zalev Brothers. The annual criterion of 60 ug/m³ was exceeded at stations 12050 and 12038 with geometric mean concentrations of 75 and 79 ug/m³ respectively. The annual criterion was not exceeded at the other 3 monitoring stations near Zalev Brothers Ltd. Figure 2 shows the annual geometric mean and the percentage of exursions above the 24-hour criterion for the various monitoring stations. The area near Zalev Brothers Limited is enlarged.

Total suspended particulate levels were higher in 1985 at station 12013, which is located near the casting plant of Ford Motor Company of Canada, Limited. The annual geometric mean value of 77 ug/m³ was the highest for this station in six years and well in excess of the 60 ug/m³ criterion. The 24-hour criterion of 120 ug/m³ was exceeded 18 percent of the time, which equalled the frequency of excursions for 1982 and was the highest excursion rate in six years.

For September 4, 1985 the total suspended particulate level for station 12013 was 333 ug/m³ and the levels of iron and manganese (metals used to identify emissions from the iron and steel industry) were also elevated with levels of 14.2 and 1.140 ug/m³ respectively. Winds were blowing persistently from the southwest which would carry emissions from the casting plant towards the monitoring site. The next highest total suspended particulate level measured for September 4, 1985 was 209 ug/m³ which was detected at station 12050, downwind of Zalev Brothers Limited. The third highest suspended particulate level was 95 ug/m³ as detected at station 12002 located in downtown Windsor. At station 12002 on September 4, iron and manganese levels were 2.2 and 0.102 ug/m³ respectively and much lower than those at station 12013. Data for most days do not show such a clear impact from the casting plant on suspended particulate levels at station 12013.

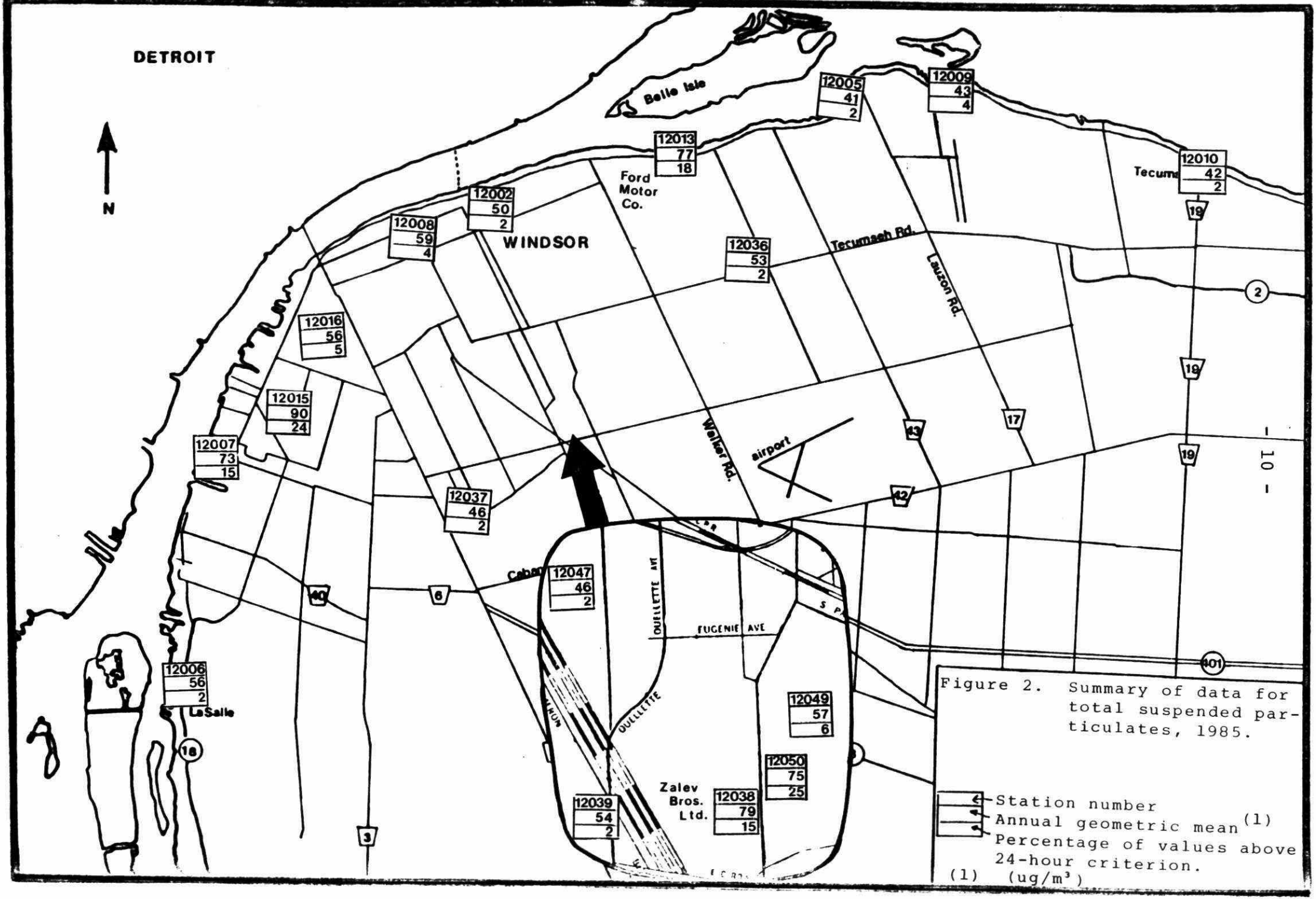


Figure 2. Summary of data for total suspended particulates, 1985.

Station number
Annual geometric mean (1)
Percentage of values above 24-hour criterion.

(1) (ug/m^3)

In west Windsor, station 12015 experienced a marked increase in TSP levels from 1983 to 1984. In 1985 levels continued to demonstrate an increase. The 1985 annual geometric mean concentration of 90 ug/m³ was appreciably higher than the 60 ug/m³ criterion for desirable ambient air and also greater than the annual geometric mean for any other monitoring station in the Windsor area. The frequencies of excursions above the 24-hour criterion for desirable ambient air quality were 3, 22 and 24 percent in 1983, 1984 and 1985 respectively. Along with the increase in TSP levels, 1985 chloride levels in TSP were 81% greater than 1984 levels. The most probable sources of the chlorides are emissions from the salt company and from roads where salt is used to reduce icy driving conditions. Chloride levels were greatest during the winter months suggesting that salt from roads is the largest contributor of chlorides, but there were incidents in the late spring and summer when chloride levels were quite elevated. Also at station 12015 iron in TSP was 20% greater in 1985 than in 1984 and manganese was 22% greater. Iron and manganese are used to detect the impact of emissions from the iron and steel industry, and therefore, part of the increase in TSP levels at station 12015 is attributed to emissions from that industry.

When comparing the annual geometric mean level of TSP for the daily sampling program at station 12008 to the annual geometric mean calculated from the normal every-sixth-day sampling schedule, the values were equal (59 ug/m³). However, the frequency of exceeding the 24-hour criterion was 9 percent based on the every-sixth-day schedule compared to 4 percent for the every-day schedule. This indicates that the every-sixth-day sampling schedule for 1985 was representative of the complete year for overall average but reflected a higher frequency of elevated levels of TSP than what actually occurred throughout 1985.

Figure 3 illustrates the average annual geometric mean concentrations for seven* monitoring stations in operation since 1972. Figure 4 illustrates the trend in frequencies of excursions above the 24-hour criterion for these same stations. Levels for 1985 were slightly greater than levels for 1984.

As part of a Province-wide study, samples of suspended particulates collected at some monitoring stations were analyzed quantitatively for cadmium, chromium, copper, iron, lead, manganese, nickel, nitrates, sulphates and vanadium. At some stations samples were analyzed for fewer parameters.

A summary of these data collected from 1981 through 1985 is presented in Appendix 2, Table A4. Data for sulphates are erroneously high based on the findings of several studies of the sampling method utilized by the Ministry. The Ministry has investigated different filter media which might provide more accurate sulphate results but have not found a filter medium that solves the sulphate problem without creating other problems. Copper results tend to be erroneously high from time to time because the vacuum pump that draws the air through the filter emits copper as a result of wear to the copper armature. These emissions can be drawn through the filter during certain meteorological conditions.

Criteria for desirable ambient air quality exist for cadmium, lead, nickel and vanadium (see Table A3). Concentrations of the various metals have been traditionally low with no values above the criteria.

* Station 12032 was terminated in April 1984 and for the trend information 1984 & 85 data from station 12007 were used with earlier data from station 12032.

Figure 3. Trend in annual levels of suspended particulates based on averaged data from seven monitoring stations.

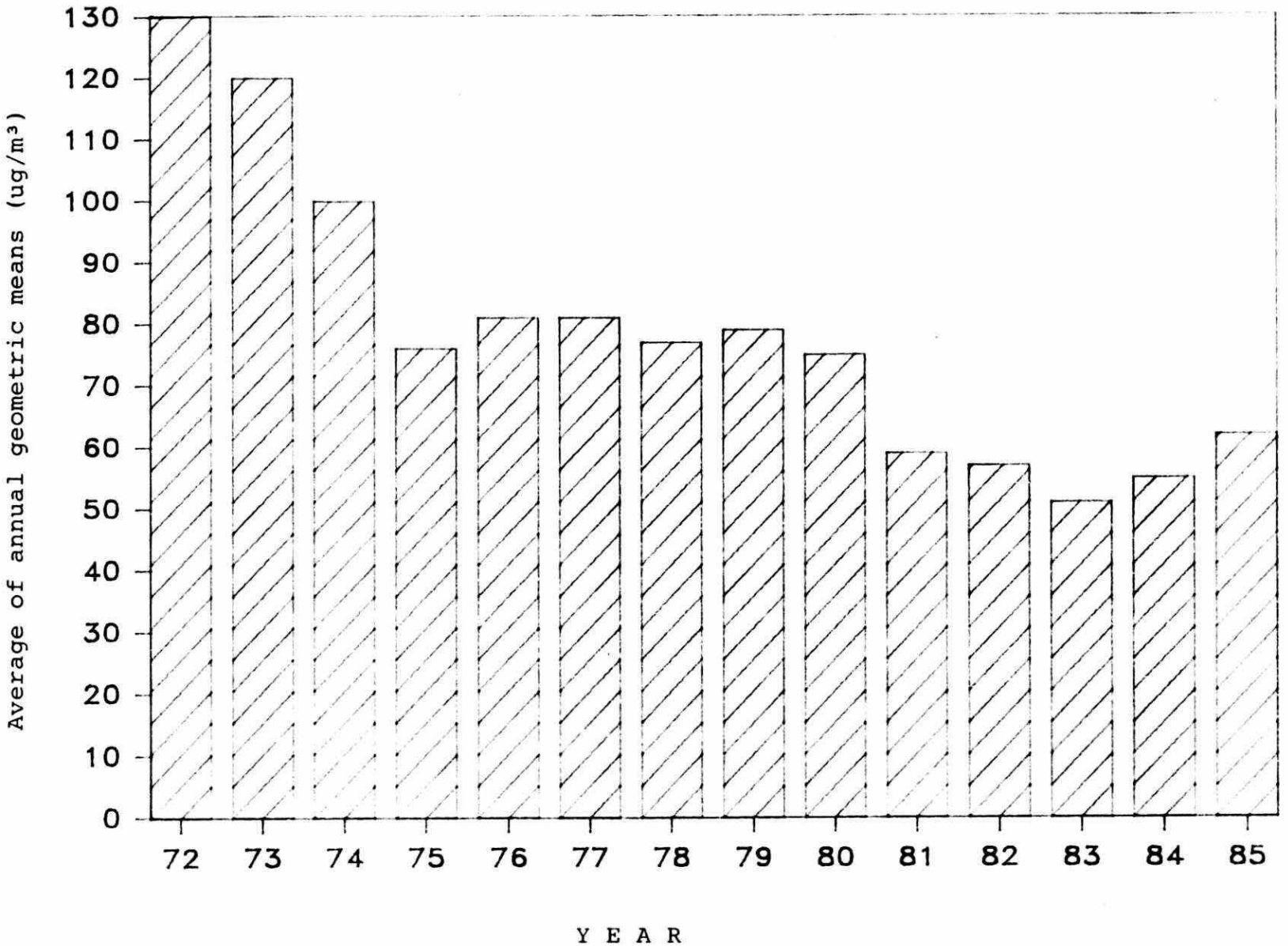
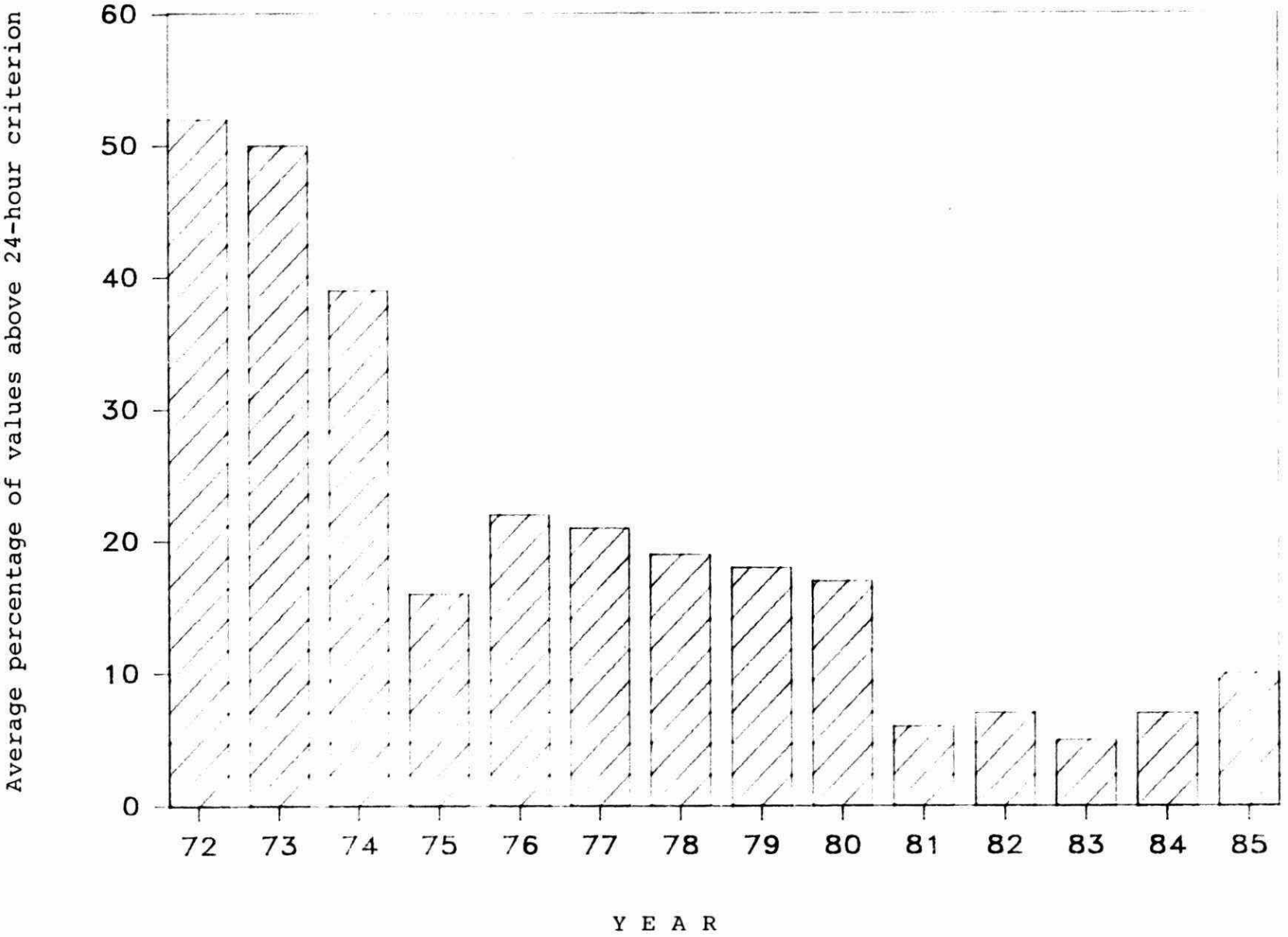


Figure 4. Trend in excursions above 24-hour criterion for total suspended partculates based on data from seven monitoring stations.



As mentioned previously, iron levels are elevated near Zalev Brothers Ltd. and the casting plant of Ford Motor Company of Canada, Limited and in west Windsor. Figure 5 contains the annual average iron concentrations at the various monitoring sites in Windsor.

SULPHUR OXIDES

Combustion of sulphur-containing fuels comprises the predominant source of man-made emissions of sulphur oxides. The primary emitters of sulphur oxides are power generating plants and industries utilizing fossil fuels to meet requirements for large amounts of energy.

During 1985 sulphur oxides were measured in Windsor as gaseous sulphur dioxide and as sulphate in suspended particulate matter. Data for sulphate in suspended particulates are presented in Table A4 supporting the section on the Suspended Particulates.

Sulphur Dioxide

The criteria for desirable ambient air quality with respect to sulphur dioxide are 0.25 parts of sulphur dioxide per million parts of air (ppm) averaged for 1 hour, 0.10 ppm averaged for 24 hours (midnight to midnight) and 0.02 ppm as an annual average. The 1-hour and annual criteria were established for the protection of vegetation while the 24-hour criterion serves to protect human health.

These criteria were not exceeded during 1985 at any of the six fixed locations in Windsor where the Ministry monitors sulphur dioxide. The monitoring locations are shown in Figure 1 as stations 12007, 12008, 12013, 12016, 12047 and 12048. A summary of the 1985 data is presented in Table 2.

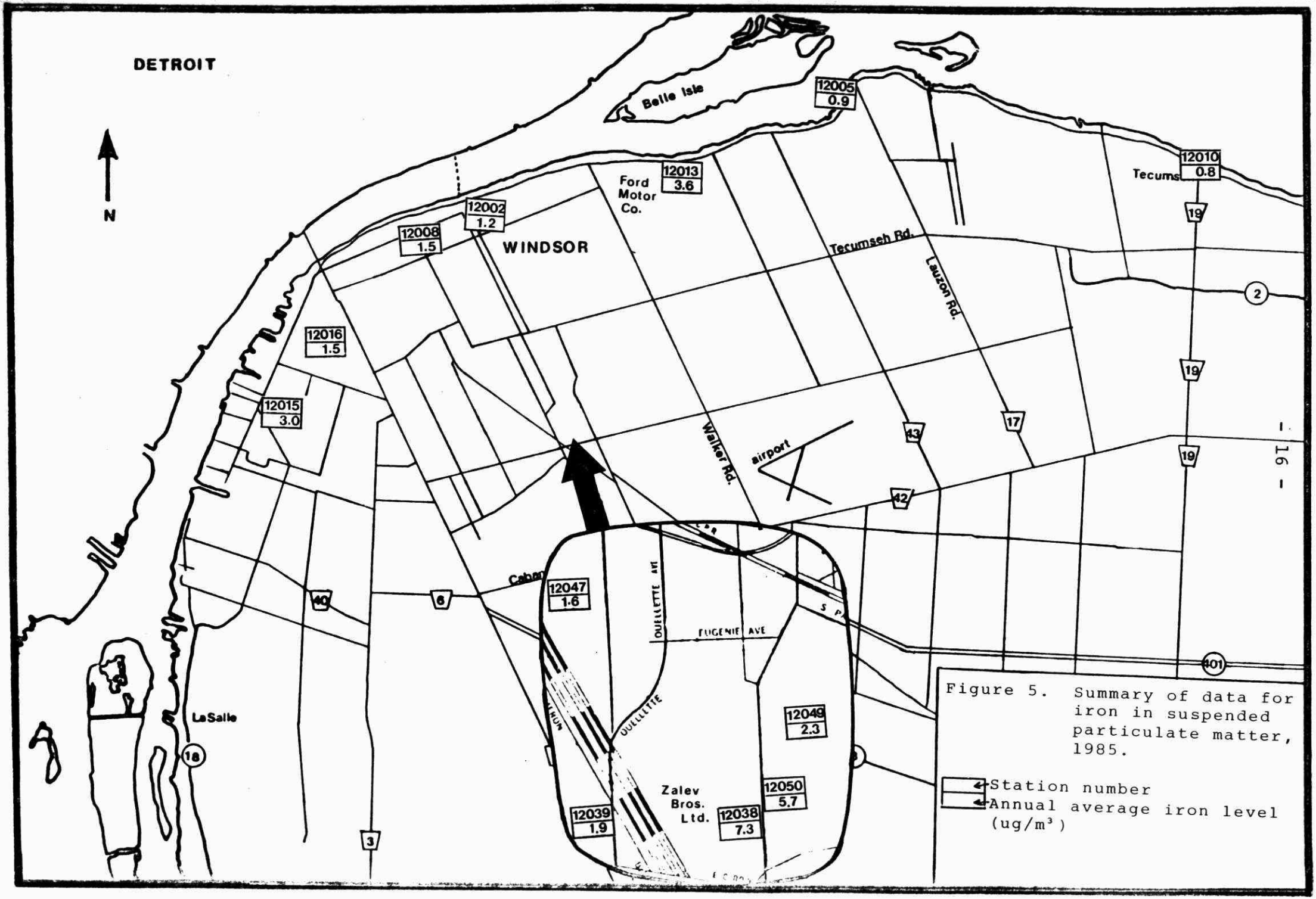

DETROIT
N
Belle Isle
12005
0.9
12010
0.8
Tecums
12013
3.6
Ford
Motor
Co.
12002
1.2
12008
1.5
WINDSOR
Tecumseh Rd.
Lauzon Rd.
12016
1.5
12015
3.0
Walker Rd.
airport
Cabana
12047
1.6
OUELLETTE AVE
EUGENIE AVE
12049
2.3
OUELLETTE
Zalev
Bros.
Ltd.
12050
5.7
12039
1.9
12038
7.3
LaSalle
401
Figure 5. Summary of data for iron in suspended particulate matter, 1985.
Station number
Annual average iron level (ug/m³)

Table 2: Summary of 1985 sulphur dioxide data.

Station Number	Annual Average (ppm)	Highest 1-hr. value (ppm)	Highest 24-hr. value (ppm)	Percentage of Values greater than 1-hr criterion	Percentage of Values greater than 24-hr criterion
12007	0.01	0.18	0.04	0	0
12008	0.01	0.10	0.03	0	0
12013	0.00	0.06	0.03	0	0
12016	0.01	0.16	0.07	0	0
12047	0.01	0.10	0.05	0	0
12048	0.01	0.09	0.03	0	0

In recent years levels of sulphur dioxide have been satisfactory and appreciably lower than the levels experienced in the early 1970's. The improvement is illustrated in Figures 6 and 7 which respectively show the frequencies of excursions above the 1-hour and the 24-hour criteria for sulphur dioxide as measured at station 12008 in downtown Windsor.

AIR POLLUTION INDEX

The Air Pollution Index (API) is a system designed to control or prevent an air pollution episode. Meteorological forecasting and readings of sulphur dioxide and suspended particulates are utilized to predict the potential for the persistence of deteriorating air quality conditions that are numerically reported as the API.

Data for suspended particulates are provided by the measurement of soiling index and a correlation between concentrations of suspended particulates and soiling index. Hourly values of soiling index and gaseous sulphur dioxide are used to compute 24-hour running averages which are inserted into the following equation:

$$API = 0.78\ (18.26\ COH + 156.7\ SO_2)^{1.06}$$

where: COH is the 24-hour average for soiling index expressed in co-efficient of haze units.

SO_2 is the 24-hour average concentration of sulphur dioxide expressed in parts per million.

API values up to 32 are considered acceptable. Values from 32 to 49 are at the Advisory Level and if adverse weather conditions are likely to persist, major emitters are advised to prepare to curtail operations. At

Figure 6. Trend in excursions above 1-hour criterion for sulphur dioxide at station 12008

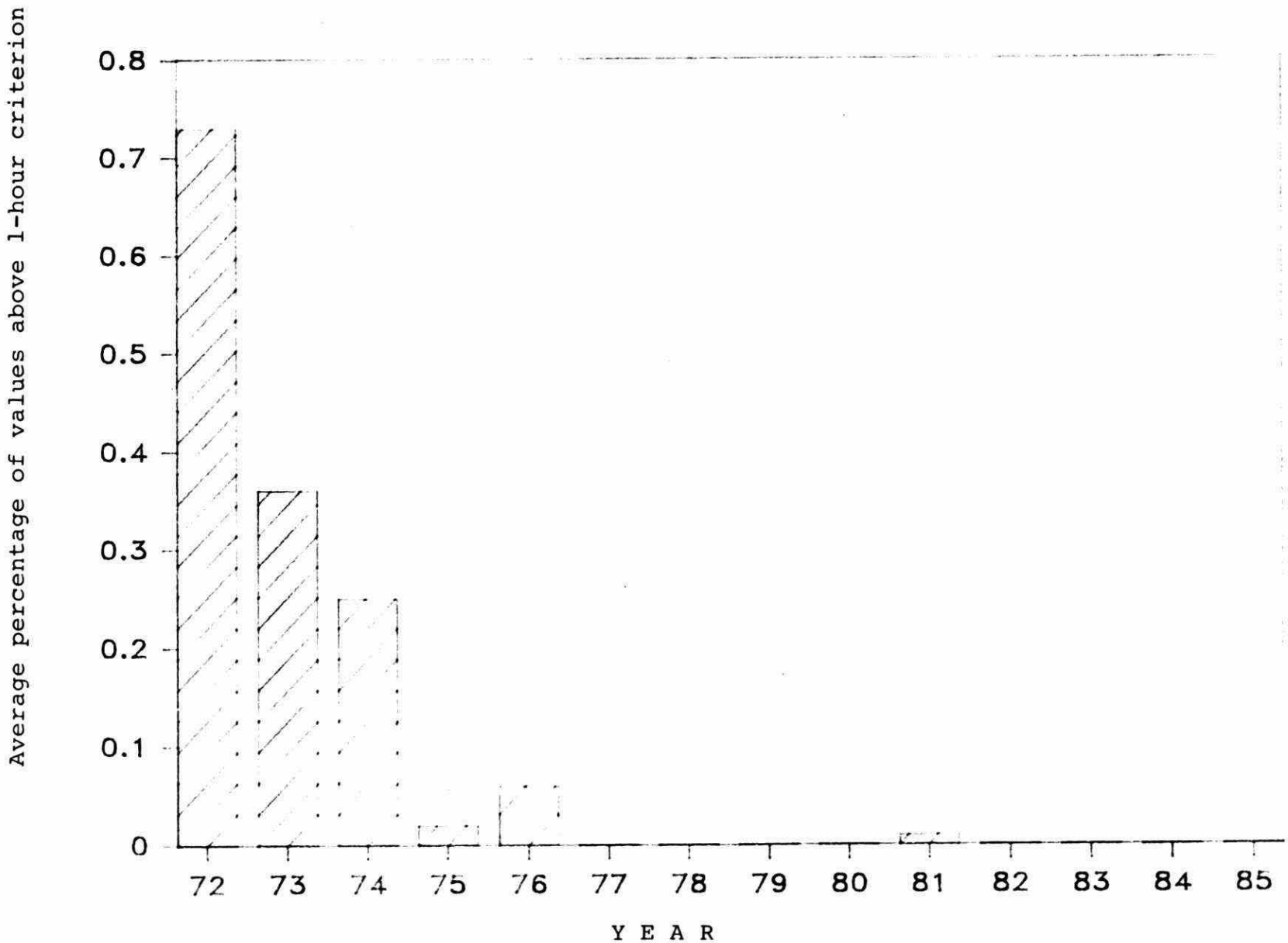
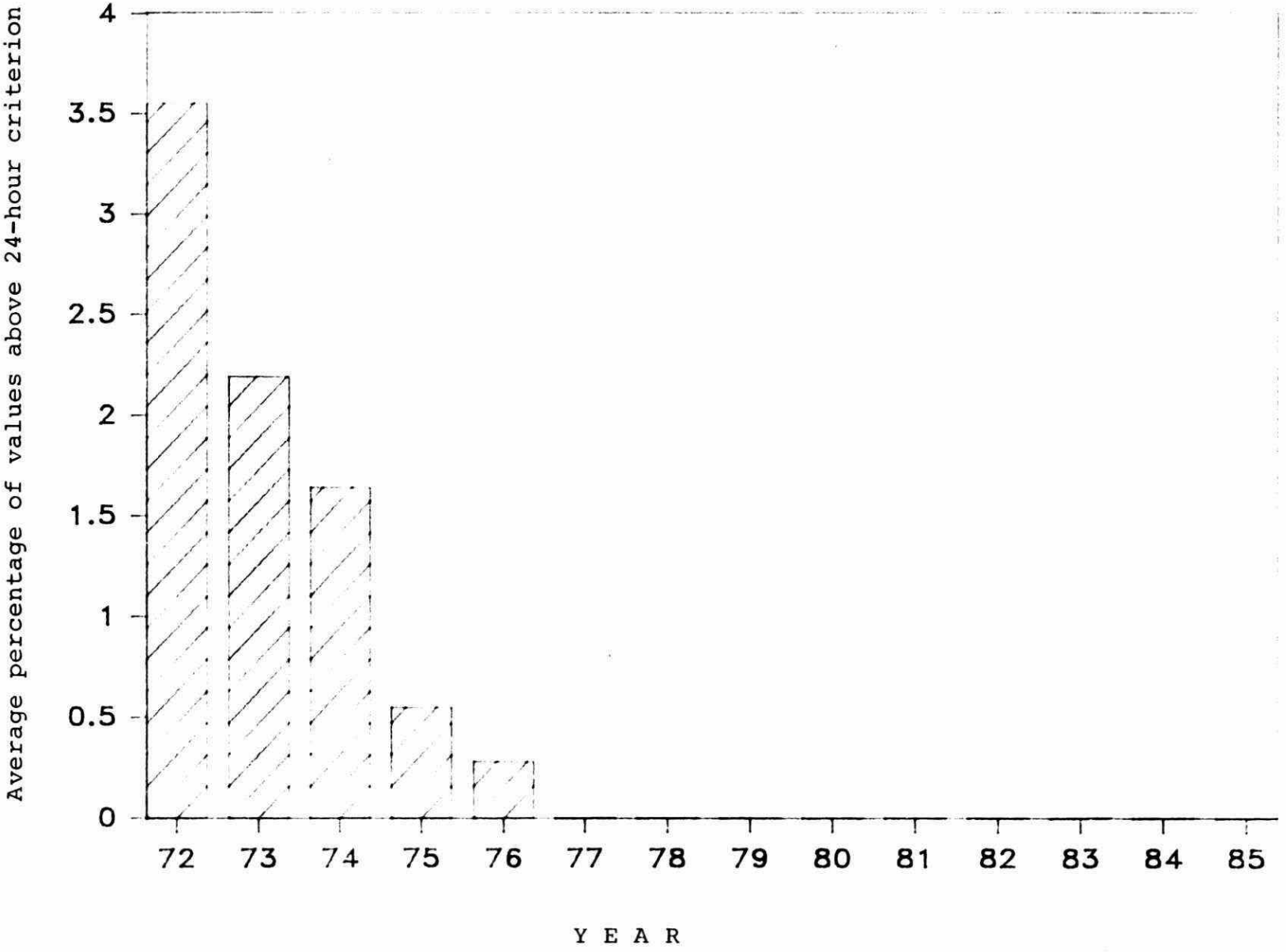


Figure 7. Trend in excursions above 24-hour criterion for sulphur dioxide at station 12008



an API of 50, major emitters may be ordered to curtail operations. At 75, further cutbacks can be required. If the API reaches 100 all industries and other pollution generating activities not essential to public health and safety can be ordered to cease operation.

Levels of soiling index and sulphur dioxide utilized for the computation of the API are obtained at station 12008 in downtown Windsor, and at station 12016 in west Windsor. During 1985 all API values were below the Advisory Level of 32.

TOTAL REDUCED SULPHUR

Gaseous total reduced sulphur compounds often exhibit malodours at very low concentrations. Hydrogen sulphide is a reduced sulphur compound commonly referred to as rotten egg gas. Mercaptans are also reduced sulphur compounds that exhibit characteristics similar to hydrogen sulphide, including being malodorous at extremely low concentrations.

There are many sources of reduced sulphur compounds including natural decomposition of organic material. In west Windsor there are occasional malodours which may be caused by reduced sulphur compounds. Probable sources of these odours are the coking operations of the steel industry in Wayne County, Michigan. There is also suspicion that some of the malodours experienced in the vicinity of the casting plant of Ford Motor Company of Canada, Limited may be caused by reduced sulphur compounds.

The Ministry of the Environment has a desirable ambient air quality criterion for mercaptans of 10 parts per billion (ppb) during a 1-hour period. There is also a

criterion for hydrogen sulphide which is 20 ppb during a 1-hour period. These criteria were established on the basis of odour. Unfortunately the instrument used by the Ministry to measure total reduced sulphur compounds does not differentiate between hydrogen sulphide and mercaptans. The instrument reports the combined levels of hydrogen sulphide and mercaptans as total reduced sulphur, expressed as hydrogen sulphide. In consideration of the combined levels measured by the instrument, the levels are compared with the less restrictive criterion for hydrogen sulphide.

During 1985 monitoring for total reduced sulphur was conducted at station 12007 in west Windsor and station 12013 near the casting plant of Ford Motor Company of Canada, Limited. No excursions were measured at station 12013. At station 12007 there were 60 excursions measured above the 1-hour criterion. Elevated levels at station 12007 were generally associated with winds blowing from the steel industry in Wayne County, Michigan. A summary of data for total reduced sulphur compounds is presented in Appendix 3, Table A5.

CARBON MONOXIDE

Combustion processes account for man's major emissions of carbon monoxide. Emissions from motor vehicles are especially significant because they are near ground level and are concentrated in urban areas where the public may be exposed for long periods. Major industries and power generating plants normally provide adequate dispersion for their emissions to prevent unsatisfactory levels of carbon monoxide in ambient air.

The criteria for carbon monoxide are 30 ppm averaged for 1 hour and 13 ppm averaged for any consecutive 8 hours. These criteria were established for the protection

of human health and have not been exceeded in the past 10 years, based on monitoring at station 12008. Since this station is located in the downtown area of Windsor where the highest levels of carbon monoxide are anticipated, there is a high probability that levels are acceptable throughout the Windsor area.

A summary of data for carbon monoxide, obtained since 1972, is presented in Appendix 3, Table A5. Data obtained from 1972 to 1976 are higher than data for the past 9 years. The differences in measured levels are attributed in part to replacement in late 1976 of a less accurate monitoring instrument with a more sophisticated one.

OXIDES OF NITROGEN

Like many other pollutants, oxides of nitrogen are emitted into the atmosphere by man through combustion processes. Nitric oxide and nitrogen dioxide are of primary interest.

Criteria for desirable ambient air quality exist for nitrogen dioxide, but not for nitric oxide or total oxides of nitrogen. The criteria for nitrogen dioxide, which are based on the protection of human health and offensive odours, are 0.20 ppm averaged for 1 hour and 0.10 ppm averaged for 24 hours (midnight to midnight).

During 1985 the criteria were not exceeded. The 24-hour criterion has not been exceeded at station 12008, located in downtown Windsor, since the chemiluminescence-type monitor was installed in 1974. During the same time period there has been only one excursion above the 1-hour criterion. Since emissions from motor vehicles are concentrated in the downtown area, levels of oxides of nitrogen would probably be higher at station 12008 than in other areas of Windsor. A summary of the data for oxides of nitrogen is presented in Table A5, Appendix 3.

Although levels of nitrogen dioxide have been very favourable when compared to the criteria, there is concern about oxides of nitrogen because of acidic precipitation and their role in the formation of unsatisfactory levels of photochemical oxidants. Consequently, more stringent controls for oxides of nitrogen are under consideration.

HYDROCARBONS

The principal man-made sources of hydrocarbons are emissions from landfill sites and motor vehicles. Other significant man-made sources are incomplete combustion of fuels by industries and power generating plants and evaporation losses during manufacture, use, storage and transportation of materials containing volatile hydrocarbons. In the Windsor area, hydrocarbon emissions from distilleries and distillery warehouses account for a large proportion of emissions from stationary sources. Also emissions from motor vehicle painting are significant in the Windsor area. Natural phenomena produce many hydrocarbons of which methane is the most abundant.

Owing to the wide range of effects associated with different hydrocarbons at various concentrations, no criteria for desirable ambient air quality have been established for total hydrocarbons. Instead, control is achieved by setting criteria for desirable levels of specific hydrocarbons in ambient air and/or establishing standards which control the impact of emissions of specific hydrocarbons.

Although there are no criteria for total hydrocarbons, monitoring for them provides information on trends in levels of hydrocarbons. Increasing levels of hydrocarbons could be significant should they be attributable to detrimental compounds. Furthermore, the non-methane or "reactive"-hydrocarbons may partake in photochemical reactions which produce excessive levels of oxidants.

Total hydrocarbons, methane and non-methane hydrocarbons are monitored continuously at station 12008 in downtown Windsor using flame ionization detection. Continuous monitoring for other specific hydrocarbons is not done. However, when problems are suspected special monitoring surveys are conducted for specific hydrocarbons. These surveys are often very complicated and difficult and often must be repeated several times to properly identify and quantify specific hydrocarbons. Levels of total hydrocarbons and reactive hydrocarbons at station 12008 have been similar in recent years with no trend of changing levels apparent. A summary of annual average concentrations appears in Table A5, Appendix 3.

OXIDANTS

A major portion of the oxidants in ambient air are a result of photochemical reactions and inter-reactions involving oxides of nitrogen and reactive hydrocarbons. The reactions are promoted by certain meteorological conditions such as warm temperatures and intense sunshine. Consequently, higher levels of oxidants are experienced in the spring and summer months.

Ozone normally accounts for 80 to 90 percent of the photochemical oxidants in ambient air. The monitoring technology for ozone is more accurate and efficient than that for total oxidants. For these reasons, most regulatory agencies, including this Ministry, monitor for ozone rather than total oxidants.

Ozone is also present in the stratosphere where it plays the critical role of absorbing ultraviolet radiation that in excessive amounts may be biologically harmful. Occasionally ozone from the stratosphere may be transported downwards to cause elevated concentrations at the earth's surface. Ozone is naturally produced in minor amounts by lightning.

Long-range transport of ozone and its precursor chemicals (oxides of nitrogen and hydrocarbons) can account for a very significant portion of local levels of ozone. Incidents of long-range transport from distances greater than 200 kilometres have been reported in the literature. Consequently, successful control of oxidants will depend on control strategies implemented in the United States as well as in Ontario.

The Environmental Protection Agency (EPA) in the United States has established a primary standard for ozone of 0.12 ppm averaged for 1 hour. Individual states are required to bring ozone levels into compliance with the standard by the end of 1987.

The Ontario criterion for desirable ambient air quality is 0.08 ppm averaged for 1 hour. This criterion was established for the protection of vegetation, property and human health. Some effects detrimental to health that are associated with oxidants are eye irritation and a decrease in performance during physical activities. Oxidant damage to crops in Ontario is estimated at millions of dollars annually. Ontario has established a special section in its Long-Range Transport of Air Pollutants program to study the oxidant situation and to develop a suitable control strategy. More stringent standards are proposed for motor vehicles in Canada which should significantly reduce oxidant precursor emissions.

Ozone is monitored by a chemiluminescence-type instrument at station 12008, in downtown Windsor. During 1985 there were 77 hourly values reported in excess of the 1-hour criterion, all of which occurred during the months of June through September. With photochemical formation of ozone being dependent on meteorological conditions, there may be large fluctuations from year to year in the frequency of excursions above the criterion. A summary of ozone data, presented in Appendix 3, Table A5, shows that the frequency of excursions above the criterion was lower in 1985 than in 1984 or 1983.

FLUORIDES

Sources of fluorides in the Windsor area are the steel industry located in the downriver area of Wayne County, Michigan, power generating plants where coal burned contains trace amounts of fluorides, fluorspar unloading operations at docks in west Windsor and subsequent trucking of fluorspar to a location south of Windsor.

Fluoridation rate is a measurement designed to indicate the relative amounts of gaseous fluoride present over an extended period of time. A lime-impregnated filter is exposed to ambient air for thirty days and then analyzed for fluoride content. This monitoring technique measures primarily gaseous fluoride but some fluoride in particulate form may be collected on the filter.

The criteria for desirable ambient air quality established for fluoridation rate are based on the protection of vegetation. Consequently, a criterion of 40 micrograms of fluoride per 100 square centimetres of filter per 30 days (ug F/100 cm^2/30 days) has been established for the growing season from April 15 to October 15 while a criterion of 80 ug F/100 cm^2/30 days applies for the period of October 16 to April 14. Since the months of April and October are common to both criteria and fluoridation rate is measured on a monthly basis, excursions during these months are determined by comparing the fluoridation rate to the average of the two criteria (60 ug F/100 cm^2/30 days). In recent years, investigations of vegetation have not revealed any appreciable damage to vegetation in Windsor attributable to fluorides.

During 1985 there were seven sites where fluoridation rates were monitored, 4 in west Windsor and 3 in the downtown area. The growing season criterion was exceeded once at station 12008 in downtown Windsor and was not

exceeded at any other station in 1985. The non-growing season criterion was not exceeded in 1985. Figure 8 shows that again in 1985 fluoridation rates were higher in west Windsor than in LaSalle or the downtown area. The 1985 fluoridation rates appear in Table 3.

Fluoridation rate is not considered a sensitive indicator of temporal trends of fluoride levels. However, based on data from six monitoring stations in operation since 1972 (1), the annual average of fluoridation rate and the frequencies of excursions above the criteria for desirable ambient air quality have been lower in recent years with the lowest values experienced in 1985. Figures 9 and 10 show the trend towards lower levels of fluoridation rates.

(1) Data for station 12007 has been used in substitution for data for station 12032 which was terminated in 1984.

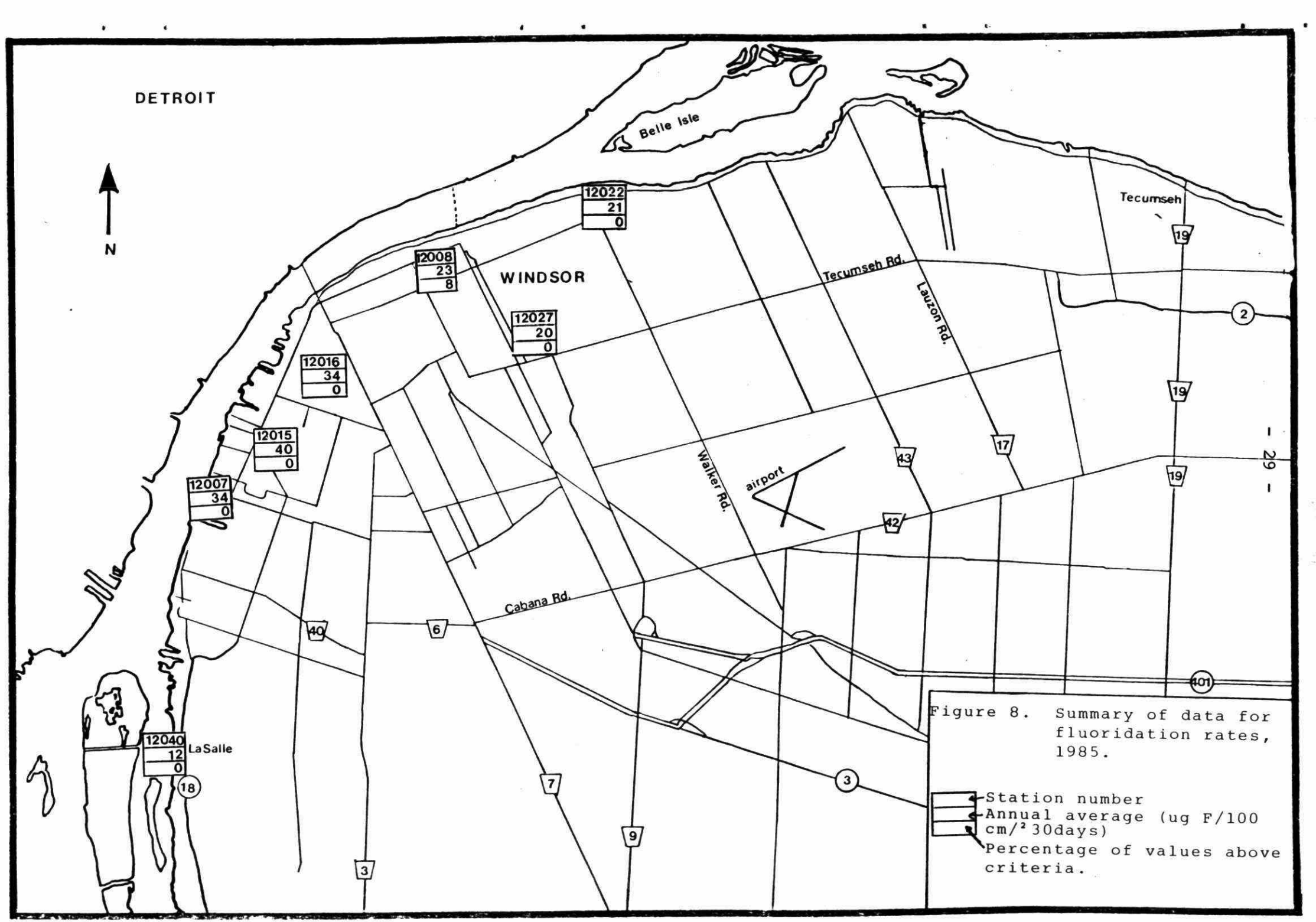


Figure 8. Summary of data for fluoridation rates, 1985.

Station number
Annual average (ug F/100 cm/² 30days)
Percentage of values above criteria.

Table 3. Levels of fluoridation rate during 1985

Station Number	Fluoridation rate (ugF/100 cm^2/30 days)													
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Average	Percentage of values above criteria
12007	43	51	43	46	12	27	33	11	18	28	24	52	32	0
12008	23	25	10	24	<u>46</u>	22	10	12	18	13	38	29	23	8
12015	46	43	48	48	15	20	23	14	24	36	74	57	37	0
12016	42	36	40	37	31	18	19	11	18	24	19	57	29	0
12022	9	40	17	22	27	10	12	9	13	15	48	25	21	0
12027	33	42	18	16	14	9	11	7	14	13	39	23	20	0
12040	21	17	15	17	7	5	10	4	10	12	16	14	12	0

Note: Underlined value exceeds criterion for desirable ambient air quality.

Figure 9. Trend in annual levels of fluoridation rate based on averaged data for six monitoring stations.

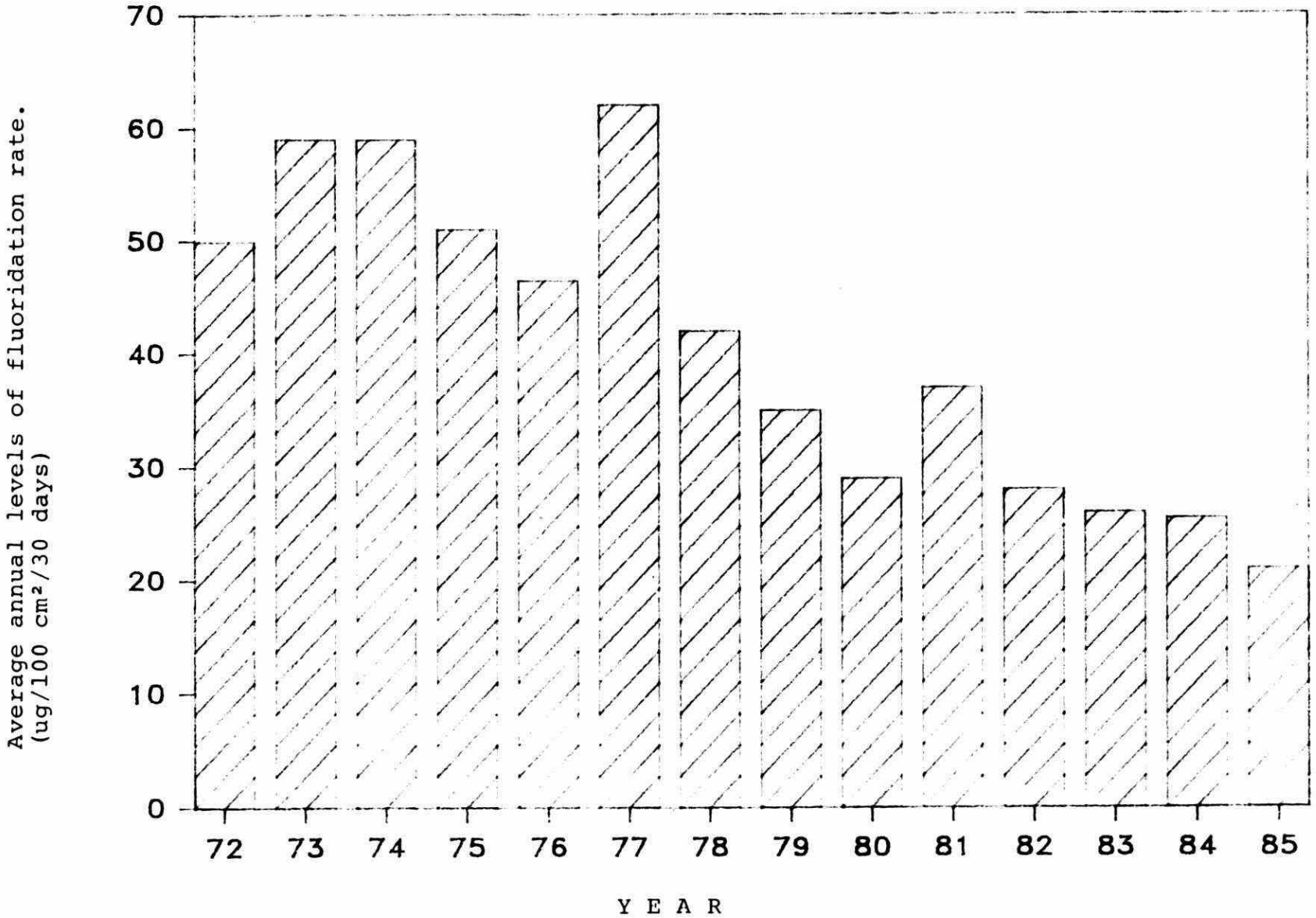
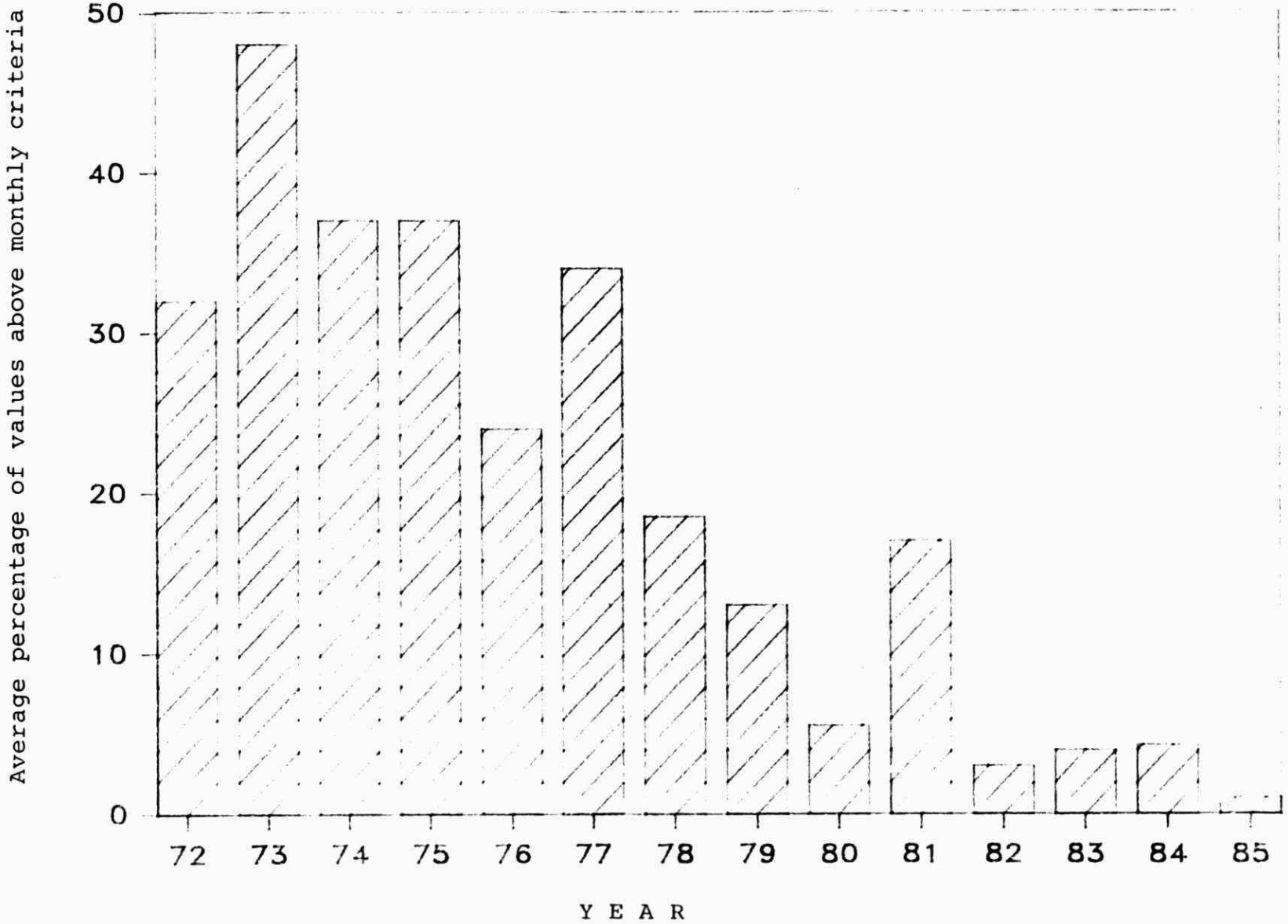


Figure 10. Trend in excursions above monthly criteria for fluoridation rate based on averaged data for six monitoring stations.



APPENDIX 1

DESCRIPTION OF MONITORING NETWORK

Table A1. Locations of air monitoring stations

Station number	Location	Universal transverse mercator projection co-ordinates	Elevation above sea level (metres)	Air intake height (metres)
12002	444 Windsor Avenue, City Hall	03323 - 46867	183	17
12005	7730 Riverside Drive East	03395 - 46890	177	10
12006	Beach Lane/Hwy. 18 (LaSalle)	03264 - 46778	176	4
12007	Wright St./Water St.	03271 - 46823	177	4, 10 & 46
12008	467 University Avenue	03316 - 46867	183	12
12009	Tecumseh Water Works	03413 - 46888	180	2
12010	Tecumseh Sewage Pumping Station	03460 - 46875	181	1
12013	3665 Wyandotte Street East	03358 - 46874	185	7 & 10
12015	Highway No. 18/Prospect	03283 - 46833	175	6
12016	College/South Street	03290 - 46841	175	4
12022	Hickory/Richmond Street	03352 - 46870	183	5
12027	1526 Parent Street	03340 - 46852	183	5
12036	1794 Westcott Street at Milloy Street	03367 - 46858	186	5
12037	3225 California Street (St. Hubert's School)	03327 - 46816	183	4
12038	2885 Howard Ave.	03342 - 46826	195	1
12039	Dougall St./E. C. Row W	03337 - 46821	195	5
12040	225 Willow Drive (La Salle)	03261 - 46773	175	5
12047	Dorwin Plaza, Dougall Ave.	03327 - 46834	187	3
12048	Malden Rd./Laurier Ave.	03299 - 46766	178	3
12049	643 Alexandrine St.	03343 - 46832	190	1
12050	535 Charles St.	03343 - 46827	195	1

Table A2. Parameters monitored in the ambient air in Windsor during 1985

Station Number	Air Pollution Index	Carbon Monoxide	Fluoridation Rate	Hydrocarbons	Nitric Oxide	Nitrogen Dioxide	Nitrogen Oxides	Ozone	Soiling Index (1-hr COH)	Sulphur Dioxide	Suspended Particulates	Total Reduced Sulphur
12002											X	
12005											X	
12006											X	
12007			X							X	X	X
12008	X	X	X	X	X	X	X	X	X	X	X	
12009											X	
12010											X	
12013										X	X	X
12015			X								X	
12016	X		X						X	X	X	
12022			X									
12027			X									
12036											X	
12037											X	
12038											X	
12039											X	
12040			X									
12047										X	X	
12048										X		
12049											X	
12050											X	

Table A3. Desirable ambient air quality criteria established by the Ontario Ministry of the Environment

Parameter	Desirable ambient air quality criteria	Prime reasons for establishing criteria or monitoring parameter
Carbon monoxide	30 ppm averaged for 1 hour	Protection of human health
	13 ppm averaged for 8 hours	Protection of human health
Fluoridation rate	40 ug of fluorides/100 cm^2 of limed filter paper in 30 days during April 15 to October 15	Protection of vegetation
	80 ug of fluorides/100 cm^2 of limed filter paper in 30 days during October 16 to April 14	Protection of vegetation (less restrictive criterion during the non-growing season)
Hydrocarbons (total)	None	Effects of hydrocarbons vary widely depending on their chemical-physical nature
Hydrogen Sulphide	0.02 ppm averaged for 1 hour	Protection against offensive odours
Mercaptans	0.01 ppm averaged for 1 hour	Protection against offensive odours
Nitric oxide	None	Reacts with oxygen to produced NO_2
Nitrogen dioxide	0.20 ppm averaged for 1 hour	Protection of human health and protection against odours
	0.10 ppm averaged for 24 hours	Protection of human health and protection against odours
Oxides of nitrogen	None	

Table A3. continued

Parameter	Desirable ambient air quality criteria	Prime reasons for establishing criteria or monitoring parameter
Ozone	0.08 ppm averaged for 1 hour	Protection of vegetation, property and human health
Sulphur dioxide	0.25 ppm averaged for 1 hour	Protection of vegetation
	0.10 ppm averaged 1 day (24 hours)	Protection of human health
	0.02 ppm averaged for 1 year	Protection of vegetation
Suspended particulates	120 ug/m^3 averaged for 24 hours	Based on impairment of visibility and health effects
	60 ug/m^3 (geometric mean) during 1 year	Based on public awareness of visible pollution
Cadmium in suspended particulates	2.0 ug/m^3 averaged for 24 hours	Based on protection of human health
Lead in suspended particulates	5.0 ug/m^3 averaged for 24 hours	Based on protection of human health
	2.0 ug/m^3 as a geometric mean over a 30 day period	Based on protection of human health
Nickel in suspended particulates	2.0 ug/m^3 averaged for 24 hours	Based on protection of vegetation
Vanadium in suspended particulates	2.0 ug/m^3 averaged for 24 hours	Based on protection of human health

APPENDIX 2

PARTICULATES

Table A4. Summary of constituents in suspended particulate matter (ug/m^3)

Station and Year	Cadmium # of samples	Cadmium Avg.	Cadmium Max.	Chromium # of samples	Chromium Avg.	Chromium Max.	Copper # of samples	Copper Avg.	Copper Max.
12002									
1981	55	0.003	0.024	55	0.006	0.027	55	0.03	0.20
1982	51	0.003	0.014	51	0.007	0.090	51	0.05	0.15
1983	33	0.002	0.009	33	0.004	0.016	33	0.06	0.10
1984	34	0.002	0.012	34	0.004	0.009	34	0.05	0.10
1985	57	0.003	0.015	57	0.012	0.066	57	0.10	0.25
12005									
1981	59	0.003	0.035	59	0.004	0.030	58	0.05	0.27
1982	54	0.005	0.022	53	0.006	0.043	54	0.06	0.67
1983	52	0.002	0.010	48	0.002	0.011	52	0.08	0.29
1984	53	0.001	0.005	53	0.004	0.034	53	0.02	0.09
1985	59	0.002	0.005	59	0.009	0.016	59	0.04	0.14
12008									
1981	307	0.003	0.042	307	0.005	0.043	307	0.15	0.82
1982	318	0.003	0.027	317	0.005	0.024	319	0.14	0.68
1983	328	0.002	0.025	328	0.004	0.015	328	0.29	1.64
1984	344	0.003	0.031	343	0.005	0.117	344	0.21	2.24
1985	325	0.004	0.025	325	0.010	0.032	325	0.13	0.72
12010									
1981	55	0.002	0.012	55	0.004	0.031	55	0.10	0.50
1982	57	0.002	0.005	56	0.002	0.009	57	0.14	0.30
1983	33	0.001	0.004	33	0.002	0.009	33	0.10	0.22
1984	32	0.001	0.004	32	0.004	0.024	32	0.05	0.09
1985	58	0.002	0.006	58	0.010	0.026	58	0.07	1.31
12013									
1981	53	0.002	0.011	53	0.008	0.029	53	0.14	0.31
1982	56	0.003	0.014	56	0.016	0.089	56	0.24	0.63
1983	56	0.002	0.011	56	0.009	0.044	56	0.14	0.34
1984	58	0.002	0.008	58	0.008	0.056	58	0.08	0.26
1985	57	0.003	0.012	57	0.012	0.029	57	0.18	0.57
12015									
1981	58	0.004	0.022	57	0.009	0.037	57	0.13	0.29
1982	53	0.005	0.074	53	0.008	0.059	53	0.20	3.09
1983	57	0.002	0.009	57	0.004	0.020	57	0.15	0.75
1984	47	0.003	0.027	47	0.006	0.019	47	0.22	0.78
1985	58	0.007	0.041	58	0.011	0.031	58	0.25	1.15

Table A4. Summary of constituents in suspended particulate matter (ug/m^3)

Station and Year	Lead # of samples	Lead Avg.	Lead Max.	Nickel # of samples	Nickel Avg.	Nickel Max.	Vanadium # of samples	Vanadium Avg.	Vanadium Max.
12002									
1981	58	0.3	2.0	55	0.011	0.070	12	0.01	0.02
1982	54	0.3	1.0	51	0.007	0.027	55	0.01	0.02
1983	49	0.3	0.9	33	0.004	0.020	33	0.00	0.01
1984	57	0.1	0.6	34	0.003	0.008	34	0.01	0.02
1985	57	0.2	0.6	57	0.007	0.031	57	0.01	0.02
12005									
1981	59	0.3	2.6	58	0.008	0.085	50	0.01	0.03
1982	54	0.2	1.1	54	0.011	0.085	54	0.00	0.02
1983	51	0.2	0.6	52	0.004	0.017	50	0.00	0.01
1984	53	0.2	0.7	49	0.004	0.036	53	0.00	0.02
1985	59	0.1	0.3	59	0.010	0.298	59	0.01	0.03
12008									
1981	316	0.4	2.0	296	0.008	0.041	307	0.01	0.03
1982	313	0.3	1.3	318	0.007	0.071	319	0.01	0.03
1983	328	0.3	0.9	306	0.005	0.084	328	0.01	0.02
1984	345	0.3	1.1	343	0.007	0.234	343	0.01	0.14
1985	325	0.2	0.7	325	0.009	0.118	325	0.01	0.03
12010									
1981	55	0.2	0.6	55	0.004	0.018	55	0.00	0.02
1982	55	0.2	0.8	57	0.006	0.018	57	0.00	0.05
1983	33	0.2	0.5	33	0.003	0.014	33	0.01	0.02
1984	32	0.2	0.7	27	0.007	0.105	32	0.00	0.03
1985	58	0.1	0.5	58	0.006	0.086	58	0.01	0.02
12013									
1981	53	0.3	1.2	53	0.004	0.017	53	0.01	0.02
1982	54	0.3	1.3	56	0.009	0.029	56	0.01	0.04
1983	56	0.2	0.7	56	0.006	0.024	56	0.00	0.02
1984	58	0.2	0.6	53	0.007	0.031	58	0.00	0.02
1985	57	0.2	0.5	57	0.007	0.024	57	0.01	0.02
12015									
1981	57	0.3	1.4	57	0.008	0.047	51	0.01	0.02
1982	52	0.2	0.8	53	0.010	0.102	53	0.01	0.13
1983	57	0.2	1.0	57	0.004	0.020	57	0.01	0.07
1984	47	0.1	1.0	47	0.005	0.023	47	0.00	0.02
1985	58	0.2	0.4	58	0.008	0.055	58	0.01	0.02
12016									
1984	69	0.3	1.1						
1985	10	0.3	0.6						

Table A4. Summary of constituents in suspended particulate matter (ug/m^3)

Station and Year	Nitrate # of samples	Nitrate Avg.	Nitrate Max.	Sulphate # of samples	Sulphate Avg.	Sulphate Max.	Chloride # of samples	Chloride Avg.	Chloride Max.
12002									
1981	58	7.0	19.4	57	13.1	29.7			
1982	45	5.4	15.6	51	11.2	37.4			
1983	54	4.8	14.5	54	9.7	27.5			
1984	57	4.1	10.8	57	9.5	25.5			
1985	57	4.5	10.3	57	9.5	32.7			
12005									
1981	59	4.9	11.1	58	10.6	28.8			
1982	44	4.0	10.1	48	10.5	34.3			
1983	52	3.6	11.0	52	9.3	29.6			
1984	53	4.0	9.2	53	9.3	21.7			
1985	59	4.4	9.0	59	9.3	32.9			
12008									
1981	305	4.9	19.8	297	10.4	44.5			
1982	267	4.6	17.3	268	10.4	50.5			
1983	328	4.0	13.2	328	9.5	41.7			
1984	344	4.5	17.4	332	8.9	28.7			
1985	325	4.8	22.7	325	10.4	39.8			
12009									
1981	55	5.3	17.5	55	11.6	24.6			
1982	43	4.5	13.7	41	10.2	26.4			
1983	53	4.1	12.7	53	10.6	32.4			
1984	55	4.1	12.0	55	9.1	20.3			
1985	55	4.2	9.9	55	9.0	30.5			
12010									
1981	58	4.5	14.3	58	11.1	36.4			
1982	56	3.1	9.7	56	8.8	19.8			
1983	33	3.2	10.3	33	8.2	19.3			
1984	32	2.9	11.2	32	9.1	24.6			
1985	58	3.8	12.2	58	9.1	33.5			
12015									
1981	55	6.0	17.3	55	14.3	32.3			
1982	51	4.6	15.1	51	11.7	28.0			
1983	43	4.5	13.8	43	10.8	27.5			
1984	47	5.7	14.3	47	13.7	40.6	49	3.6	21.5
1985	58	6.0	22.9	58	13.6	34.1	58	6.5	34.4

Table A4. Summary of constituents in suspended particulate matter (ug/m^3)

Station and Year	Manganese # of samples	Manganese Avg.	Manganese Max.	Iron # of samples	Iron Avg.	Iron Max.
12002						
1981	55	0.06	0.20	55	1.8	6.9
1982	51	0.05	0.11	49	1.4	4.2
1983	33	0.04	0.11	33	1.3	3.0
1984	34	0.06	0.14	34	1.4	3.9
1985	57	0.07	0.51	57	1.2	4.0
12005						
1981	50	0.04	0.34	59	1.2	13.0
1982	53	0.03	0.10	49	0.7	2.7
1983	52	0.03	0.11	52	0.8	2.5
1984	52	0.04	0.40	53	0.8	2.5
1985	59	0.04	0.16	59	0.9	5.2
12008						
1981	307	0.06	0.25	307	1.6	7.2
1982	319	0.04	0.23	295	1.2	5.4
1983	328	0.04	0.17	328	1.2	5.5
1984	344	0.06	0.37	344	1.5	5.9
1985	325	0.08	2.50	325	1.5	5.2
12010						
1981	55	0.04	0.42	55	0.9	4.4
1982	56	0.02	0.09	52	0.5	1.8
1983	33	0.02	0.04	33	0.5	1.4
1984	32	0.02	0.05	32	0.4	1.0
1985	58	0.04	0.17	58	0.8	5.1
12013						
1981	53	0.06	0.20	56	1.8	6.4
1982	56	0.15	0.92	53	2.6	8.3
1983	56	0.15	1.14	56	3.2	16.2
1984	58	0.15	0.83	58	3.9	22.2
1985	57	0.19	1.14	57	3.6	14.2
12015						
1981	52	0.08	0.22	57	2.5	5.8
1982	52	0.05	0.15	52	2.1	27.1
1983	57	0.06	0.14	57	1.8	6.4
1984	47	0.09	0.27	47	2.5	8.0
1985	58	0.11	0.30	58	3.0	9.6
12016						
1981				10	1.7	3.3
1982				54	1.5	6.3
1983				73	1.5	4.0
1984				120	1.4	6.0
1985				116	1.5	4.7

Table A4. Summary of constituents in suspended particulate matter (ug/m^3)

Station and Year	Manganese # of samples	Manganese Avg.	Manganese Max.	Iron # of samples	Iron Avg.	Iron Max.
12038						
1985	39	0.11	0.41	39	7.3	35.1
12039						
1981				59	1.8	10.4
1982				52	1.5	12.4
1983				58	2.6	14.0
1984				56	2.3	24.8
1985				65	1.9	10.3
12047						
1985	52	0.05	0.14	52	1.6	11.2
12049						
1985	62	0.06	0.19	62	2.3	14.2
12050						
1985	63	0.09	0.38	63	5.7	50.0

APPENDIX 3

TOTAL REDUCED SULPHUR, CARBON MONOXIDE, OXIDES OF NITROGEN, HYDROCARBONS AND OZONE

Table A5. Summary of data for total reduced sulphur, carbon monoxide, oxides of nitrogen, hydrocarbons and ozone.

Parameter	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972
Station 12008														
Carbon monoxide														
Annual average (ppm)	1	1	1	1	1	2	2	2	2	4	5	5	5	5
Percentage of values greater than:														
1-hour criterion	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0
8-hour criterion	0	0	0	0	0	0	0	0	0	0	0.32	0.30	0.10	0
Nitrogen dioxide														
Annual average (ppm)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03		
Percentage of values greater than:														
1-hour criterion	0	0	0	0	0	0	0	0.01	0	0	0	0		
24-hour criterion	0	0	0	0	0	0	0	0	0	0	0	0		
Nitric oxide														
Annual average (ppm)	0.02	0.03	0.02	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04		
Total oxides of nitrogen														
Annual average (ppm)	0.04	0.05	0.04	0.04	0.05	0.05	0.05	0.07	0.07	0.06	0.06	0.07		
Total hydrocarbons														
Annual average (ppm)	2.1	2.3	2.1	2.1	2.1	2.2	1.9[(a)]	2.3	2.4	2.6	2.2	1.9	2.1	2.2
Reactive hydrocarbons														
Annual average	0.4	0.4	0.3	0.4	0.4									
Ozone														
Annual average (ppm)	0.020	0.019	0.019	0.018	0.019	0.020	0.016	0.018	0.021	0.021	0.017	0.014		
Percentage of values greater than 1-hour criterion	0.9	1.7	1.4	0.6	1.3	1.8	0.8	2.4	3.1	2.5	2.2	0.8		

(a) based on 9 months of data

Table A5. Continued

Parameter	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972
Station 12007														
Total reduced sulphur		(a)												
Annual average (ppb)	2.0	1.3												
Percentage of values greater than:														
1-hour criterion	.079	0.70												
Station 12013														
Total reduced sulphur		(a)												
Annual average (ppb)	1.4	1.5												
Percentage of values greater than:														
1-hour criterion	0.00	0.00												

(a) 7 months of data